CLAIMS

1. A method of regulating supply voltage of an integrated circuit device, comprising:

calculating a reference voltage at which performance of the integrated circuit device is substantially insensitive to temperature variations;

identifying a process split of the integrated circuit device by setting the supply voltage to the reference voltage and by measuring a corresponding reference frequency on the integrated circuit device; and

regulating the supply voltage using characterization data corresponding to the identified process split.

2. The method of claim 1, wherein the maximum regulated supply voltage is determined using characterization data corresponding to the identified process split.

3. The method of claim 1, wherein the characterization data corresponding to the identified process split comprises data comprising worst-case temperature variations.

4. The method of claim 1, wherein the characterization data comprises voltage parameters.

5. The method of claim 4, wherein each of the voltage parameters is associated with a target frequency.

6. The method of claim 4, wherein the voltage parameters are configured to accommodate worst case temperature for the identified process split.

7. The method of claim 1 wherein the reference frequency is measured at the output frequency of a ring oscillator.

8. The method of claim 7 further comprising calculating the output frequency of the ring oscillator with a target frequency of operation of a processing circuit on the integrated circuit device.

9. The method of claim 1 wherein the maximum supply voltage is computed based on the process split of the integrated circuit device.

10. The method of claim 1 wherein the process splits comprise slow, typical and fast.

11. The method of claim 1 further comprising maintaining data comprising the measured reference frequency indexed to the corresponding process split.

12. The method of claim 1 wherein the regulating the supply voltage further comprises consulting, based on the identified process split, an index of target frequencies to corresponding different voltages.

13. The method of claim 1 wherein the supply voltage is regulated based on one or more desired target frequencies.

14. The method of claim 1, wherein a closed-loop feedback system is used to regulate the supply voltage.

15. The method of claim 14, wherein the supply voltage is regulated using the closed-loop feedback system after an initial supply voltage is set using the characterization data corresponding to the identified process split.

16. The method of claim 14, wherein the closed-loop feedback system comprises a replica of a critical path.

17. The method of claim 14, wherein the critical path replica comprises a ring oscillator.

18. The method of claim 1, wherein the integrated circuit device comprises a component in a portable electronic device.

19. The method of claim 18, wherein the portable electronic device comprises a mobile telephone.

20. The method of claim 1, wherein the integrated circuit device comprises a system on a chip (SOC).

21. A method of regulating supply voltage of an integrated circuit comprising:

determining a process split for the integrated circuit;

associating a plurality of voltages to the process split, each voltage corresponding to a target frequency of operation of a processing unit on the integrated circuit; and

regulating the supply voltage to attain one of the target frequencies for the processing unit using a corresponding one of the voltages associated with the determined process split.

22. The method of claim 21, wherein the determining the process split further comprises measuring the frequency of a ring oscillator on the integrated circuit at each of the voltages.

23. The method of claim 22, wherein the determining the process split further comprises determining said one of the target frequencies for the processing unit based on the measured frequencies of the ring oscillator.

24. The method of claim 22, wherein the ring oscillator is coupled to a memory circuit comprising process information to identify the process split.

25. The method of claim 21 further comprising adjusting at least some of the voltages to account for worst-case temperature variation.

26. The method of claim 21, wherein the voltages are associated with at least three process splits.

27. The method of claim 27, wherein the three process splits comprise slow, typical, and fast.

28. A voltage regulation apparatus for use on an integrated circuit device, comprising:

an automatic process identifier configured to identify a process split of the device;

a memory circuit coupled to the automatic process identifier, the memory circuit configured to store data comprising target voltages for different process splits;

a processing unit;

a power supply; and

a voltage regulator circuit coupled to the memory circuit and to the power supply, the regulator configured to adjust the power supply value according to the automatic process identifier and the memory circuit, the adjusted power supply causing the processing unit to operate substantially at a target frequency.

29. The apparatus of claim 28, further comprising

a switching device comprising a plurality of inputs and an output, a first one of the inputs of the plurality coupled to the memory circuit and the output coupled to the voltage regulator; and

a closed-loop feedback circuit coupled to a second one of the inputs of the plurality, the feedback circuit configured to adjust the power supply voltage.

30. The apparatus of claim 29, wherein the closed-loop feedback circuit comprises a critical path replica circuit configured to approximate a critical path of the processing unit.

31. The apparatus of claim 29, wherein the switching device is configured to select between adjusting the power supply based upon the automatic process identifier and the closed-loop feedback circuit.

32. The apparatus of claim 30, wherein the closed-loop feedback circuit further comprises a counter for measuring an output frequency of the critical path replica.

33. The apparatus of claim 28, wherein the memory circuit contains data comprising a plurality of target frequencies, the target frequencies corresponding respectively to each of the target voltages.

34. The apparatus of claim 32, wherein the memory circuit contains data comprising a plurality of target frequencies, the target frequencies corresponding respectively to each of the target voltages.

35. A method of regulating supply voltage of an integrated circuit device using a ring oscillator circuit for measuring frequencies corresponding to different voltages, comprising

recording ring oscillator frequencies for different voltages at a plurality of process splits associated with a family of silicon devices in which the integrated circuit device is included, each of the ring oscillator frequencies corresponding to a target frequency of operation for a processing unit on the integrated circuit device, the voltages and corresponding frequencies comprising respective sets of characterization data for each process split;

measuring, for the different voltages, an additional set of frequencies output from a ring oscillator on the integrated circuit device;

identifying the two sets of characterization data representing two process

splits having performance characteristics most closely above and below the performance characteristics characterized by the additional frequencies at the different voltages measured for the integrated circuit device;

interpolating between the identified two sets of characterization data using the additional frequencies to identify a third set of data characterizing the integrated circuit device and comprising supply voltages necessary to achieve the corresponding target operating frequencies; and

regulating the supply voltage to achieve the target frequencies using the supply voltages from the third set.

36. The method of claim 35, wherein the ring oscillator frequencies associated with the different process splits are recorded at different temperatures.

37. The method of claim 35, wherein the additional set of frequencies are measured at the different temperatures.

38. The method of claim 35, wherein the process splits comprise slow, typical and fast.

39. The method of claim 35, wherein the regulating the supply voltage further comprises receiving input from a performance monitor comprising the desired target frequencies of operation of the processing unit.

40. The method of claim 35, wherein the recording ring oscillator frequencies is performed prior to mass producing the family of integrated circuit devices.

41. The method of claim 40, wherein the measuring, identifying, interpolating, and regulating are performed during a calibration phase.

42. A voltage regulation apparatus for use in an integrated circuit device, comprising:

a processing unit;

an identifier circuit configured to identify a process split for the integrated circuit device;

a memory circuit coupled to the identifier circuit, the memory circuit containing characterization data for the identified process split;

a critical path replica circuit comprising an output for providing frequency information approximating a critical path of the integrated circuit;

a switch coupled to the memory circuit and the output of the critical path replica circuit; and

a voltage regulator circuit coupled to the switch and a supply voltage of the integrated circuit device, the regulator circuit configured to adjust the supply voltage to achieve a desired target frequency of the processing unit.

43. The apparatus of claim 42 wherein the voltage regulator controls the state of the switch.

44. The apparatus of claim 42, further comprising a circuit coupled to the memory circuit for identifying a target frequency of operation.

45. The apparatus of claim 42 wherein the voltage regulator uses the switch to select one of two modes of operation.

46. The apparatus of claim 42 wherein a first mode of operation uses characterization data provided by the memory circuit to adjust the supply voltage.

47. The apparatus of claim 46 wherein a second mode of operation uses characterization data provided by the critical path replica circuit to adjust the supply voltage.

48. Computer readable media embodying a program of instructions executable by a computer program to perform a method of regulating a supply voltage of an integrated

circuit device comprising determining a process split for the integrated circuit; associating a plurality of voltages to the process split, each voltage corresponding to a target frequency of operation of a processing unit on the integrated circuit; and regulating the supply voltage to attain one of the target frequencies for a processing unit on the integrated circuit using a corresponding one of the voltages associated with the determined process split.

49. An integrated circuit device comprising:

a processing unit;

process identification means for identifying the process split of the integrated circuit;

memory means for storing characterization data of the family of integrated circuit devices to which the integrated circuit device belongs;

means for determining the characterization data for the integrated circuit device using the memory means and the process identification means; and

voltage regulation means for adjusting the supply voltage using the characterization data for the integrated circuit device to achieve a desired target frequency of operation for the processing unit.

50. The integrated circuit device of claim 49, wherein the memory means includes characterization data for worst case temperature variation for each process split.